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AUTHOR Boyer, Robert: And Others
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ABSTRACT

This is one of a series of 14 instructional components of a semester-long, environmental earth science course developed for undergraduate students. The course includes lectures, discussion sessions, and individualized learning carrel lessons. Presented are the study guide and script for a learning carrel lesson on processes and changes that have happened on earth over long time intervals. The slides, audio-cassette tape, and other materials necessary to the lesson are not included. (BT)

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STUDY GUIDE AND SCRIPT

SECTION III: PROCESSES THROUGH TIME

LESSON 6.8: LONG TERM EVENTS

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ENVIRONMENTAL STUDIES

A Cooperative Project of The Department of Geological Sciences and the Science Education Center

The University of Texas at Austin

ED 028 781

ENVIRONMENTAL EARTH SCIENCE

"Environmental Earth Science" is a new course developed at The University of Texas at Austin by the Department of Geological Sciences and the Science Education Center. It is offered at The University of Texas at Austin as Geology 361K and has been tried out during the spring semesters of 1972, 1973, 1974, and 1975. Revisions have been made as necessary after each tryout. The project within which the course has been developed has been supported by the National Science Foundation.

The course includes lectures, discussion sessions, and individualized Learning Carrel Lessons. Extensive use has been made of multi-media technology in the presentation of the course. Learning Carrels for individualized instruction have been especially designed for this program. The lectures introduce specific topics, suggest problems or questions, and provide background information. The discussion sessions provide the student an opportunity to ask questions and clarify ideas. The discussion sessions also provide input and feedback to the instructor.

The Learning Carrel Lessons have been written by faculty and graduate students in the geological sciences and in science education. Writers and resource contributors include Dr. Robert Boyer, Dr. Rolland Bartholomew, Dr. Keith Young, Dr. Samuel Ellison, Dr. James Underwood, Dr. David Butts, Dr. Addison E. Lee, David Keller, Melanie Lewis, Wayne Schade, Ann Lee, and William McLoda. Technicians involved in production of scripts, sound, and photography were Stan Prescott, Lee West, Charles Geffen, and William McLoda. Artists were Jesus Rivas, Alice Canestaro, Aly Knox, and Javier Flores.

Each Learning Carrel Lesson consists of a set of 2 x 2 slides, an audio cassette tape, a study guide, a script, and other materials necessary to the lesson. The study guide and script are in this booklet. Students may set their own time schedule within an announced period when slides and tapes are made available.

The student should note the list of Learning Carrel Lesson topics to place in proper content the lesson in this booklet, and then read carefully the introduction, rationale, prerequisites, and lesson objectives in the study guide. The student should follow the instructions in the study guide for the entire lesson. In some instances, these instructions are also repeated on the audio cassette tape. The slides and tapes have been synchronized to automatically advance the slides appropriate to the audiotape. However, there is a tone signal given before the change of each slide so that the lesson can be used outside of the carrel if automatic facilities are not available. When the student is ready to start the lesson, the "on" switch should be pushed. If the slides and tape are operated manually, both will need to be turned "on." The first slide is always a title slide or a blank solid colored slide. If

the slides and tape are manually operated, this title or blank slide should be on view before the tape is started. For automatic operation, the slides and tapes will be set up by the Instructor or Proctor before the lesson and between each use. It is most important to start each lesson according to these instructions in order to provide synchronization of the slides and tape. Remember that slides placed in the tray to be used with a rear view screen are reversed from those to be used with a front view screen.

The student will be instructed by the study guide and/or the tape to stop at various places to carry out certain activities. Usually the audio-tape will say, "Please stop the tape now and restart only when you have finished this exercise." Therefore, the student should wait a few seconds to finish hearing the instruction after the word "Stop." However, one should not wait long enough for the tone signal or automatic change to the next slide. This signal should be heard after you restart the tape. If the lesson is moving too rapidly, the student may stop the tape and slides at any time to consult the study guide or script, but it is NOT POSSIBLE to back up and re-examine a given slide without completing the entire cycle of the lesson.

It is particularly important for the student to carry out the instructions for activities given in the study guide. In order that a record may be maintained of these activities, each student should pick up a copy of the STUDENT RESPONSE SHEET which include questions to be answered and the other activities requiring responses. These should be completed and turned in to the instructor as required for grading, feedback for the instructor, and to provide a basis for student interaction in the discussion group.

Each Learning Carrel Lesson is independent within the context of the course. Some of them provide direct information on a given topic, but in an individualized mode requiring some activities and thought on the part of the student. Others place the student in a role-playing situation where some position must be taken on provocative questions or issues. Others deal primarily with applications of environmental information. In all the lessons, the student is expected to receive basic information that is coordinated with the lectures, the small group discussions, and the readings.

ENVIRONMENTAL EARTH SCIENCE

LEARNING CARREL LESSONS

Section I: Man's Effect on Nature

Lesson 6.1: Population
Lesson 6.2: Land Use
Lesson 6.3: Urban Crisis (Field Trip)

Section II: Energy

Lesson 6.4: Energy
Lesson 6.5: Energy Resources
Lesson 6.6: Future Projections

Section III: Processes Through Time

Lesson 6.7: Geologic Time
Lesson 6.8: Long Term Events
Lesson 6.9: Short Term Events

Section IV: Natural Resources

Lesson 6.10: Minerals
Lesson 6.11: Conflicts of Interest
Lesson 6.12: Soils
Lesson 6.13: Water

Section V: Oceanography

Lesson 6.14: Ocean Resources
Lesson 6.15: Pollution of the Oceans

TO THE STUDENT:

This booklet contains two sections: (1) the Student Study Guide for this lesson, and (2) the Script or printed copy of the discussion recorded on the audio cassette tape.

You are expected to begin with the printed instructions in the Study Guide and follow them continuously as you study the lesson. In many instances the same or similar instructions may also be heard on the audio cassette tape. Refer to the script only if you need to refresh your memory as to something that was said. The script is provided because you cannot back up the tape if you need to review something already said on the tape.

Specific instructions will be given in the Study Guide as to when to start and stop the tape. Do not restart the tape until instructed to do so in the Study Guide.

Questions requiring written answers should be completed on the STUDENT RESPONSE SHEETS provided by the Instructor.

INSTRUCTIONS:

1. Read the Introduction, Rationale and Objectives for this lesson that follows. If you have questions, check with the Instructor or Proctor.

INTRODUCTION:

Science fiction writers have great fun speculating about and manipulating time. As you know, you don't have to be a science fiction writer to imagine what life was like in the past. However, you might not have realized that light we receive from stars started on its journey at the time the dinosaurs lived on earth. This star light we receive today thus represents a prehistoric view of the star -- not the way it necessarily looks today.

Wouldn't it be great if we could find ourselves suddenly way out in space moving toward the earth? If we had a super-telescope and could travel fast enough toward the earth, we'd see the complete history of the earth in our journey. This idea seems a little far-fetched so we'll take a more practical look at the earth's history. We'll use a "time machine" to look at organisms and events that have appeared on earth during long time intervals.

RATIONALE:

The study of events that have happened on earth throughout its history is important in understanding the earth we see around us today. Environmental conditions and the adaptation of living and non-living things to these conditions is not unique to the 1970's. There is a long history of the adjustments made by living and non-living things to environmental change. This lesson is designed to show some of the changes that have happened on earth over long time intervals.

OBJECTIVES OF THIS LESSON:

After taking this program, it is expected that you will be able to:

1. describe physical or biological changes that require long time intervals to come about

2. describe the evidence that is used to identify physical and biological changes occurring over long time intervals

3. distinguish between direct and indirect observations

4. explain, by means of an example, that the end of a long time event is not easily connected to its beginning without observations of intervening events

INSTRUCTIONS:

2. After taking this program you are expected to choose one of the several different paths of extended study listed below. Choose carefully and then let your creative abilities flow into your work. Here are your choices:

a. Write a 2-page paper describing how this program helped you "know more than you knew before."

b. Create a story, poem, song, sketch, etc., to show that this program helped you "understand something you didn't understand before."

c. Create a story, poem, song, or use some other expressive medium to show that this program helped you "feel differently about this subject than you felt before."

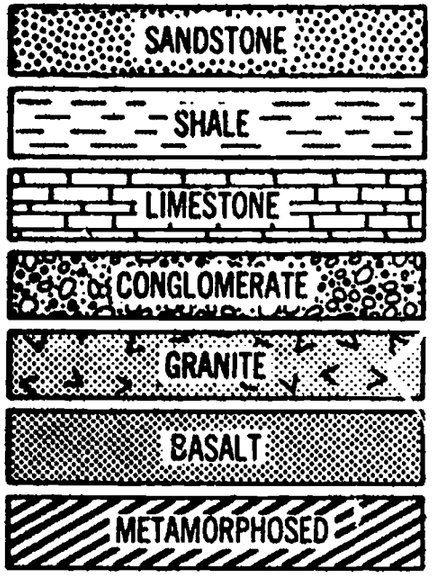
d. Write a paper or give an oral report indicating the things you did to learn more about some of the ideas contained in this program.

e. Complete the set of problems listed below.

1. On the reference shelf you'll find a set of 36 slides duplicating the ones showing the changes in life through time used in this program. Accompanying these slides is a xerox copy of the author's description of each plate. Select five of the slides you like best and identify the different life forms shown on the slides. Your identification should include: (1) scientific name, (2) common name if appropriate, (3) kingdom, (4) phylum, and (5) class.

2. Take a trip to the Texas Memorial Museum. In the lobby and on the lower floor are exhibits of prehistoric plants and animals. Select five exhibits that appeal to you. Sketch and label what you see.

3. Describe the sequence of geologic events represented in the cross-sections on the next page. (These diagrams are reproduced from ESCP, Investigating the Earth, Teachers Guide, Houghton Mifflin Company, Boston, 1967, p. 721)


SANDSTONE
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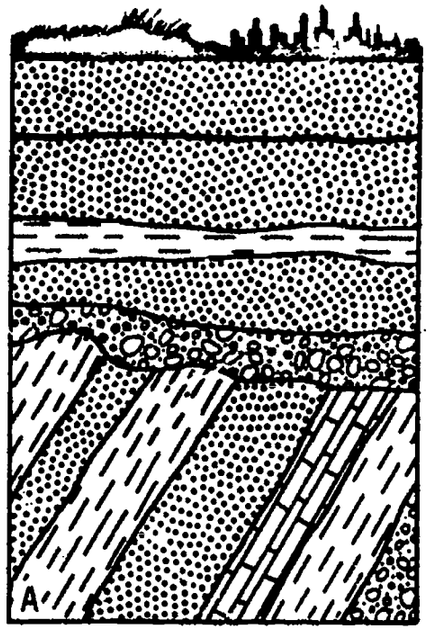
LIMESTONE
CONGLOMERATE
GRANITE
BASALT
METAMORPHOSED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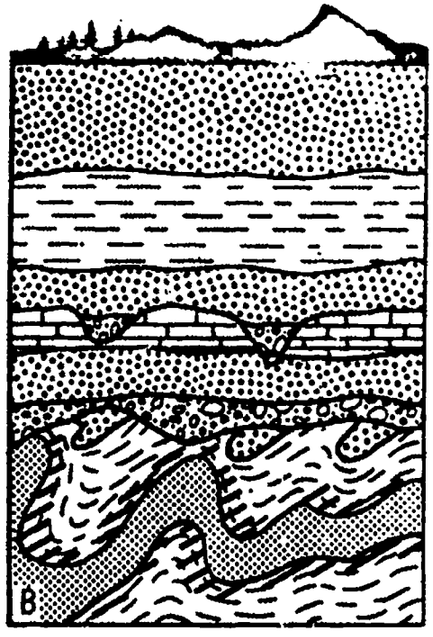
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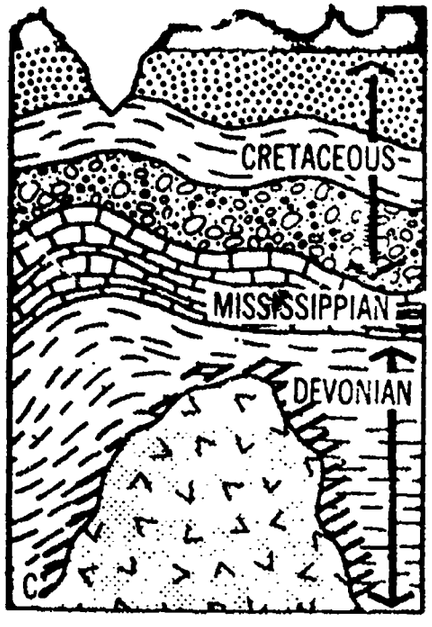
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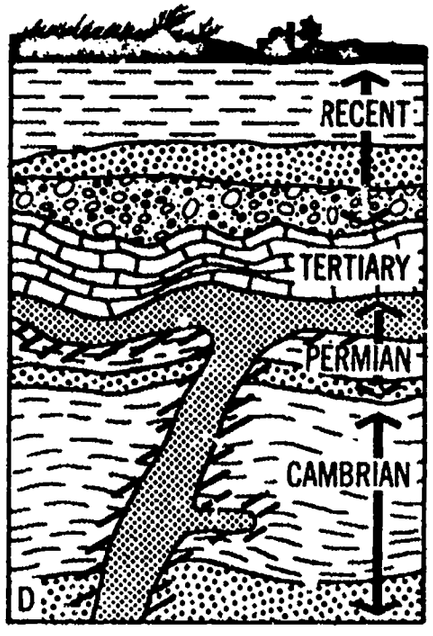
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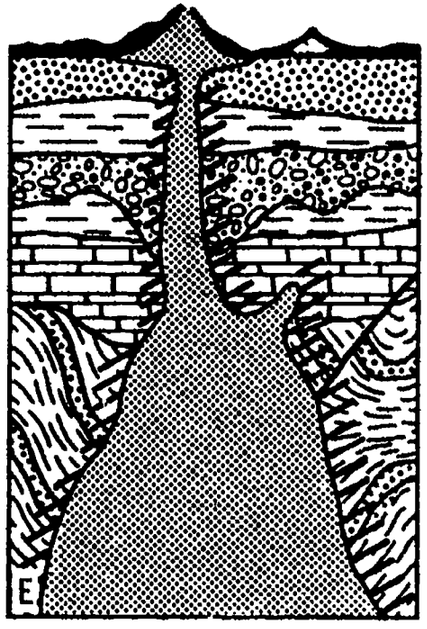
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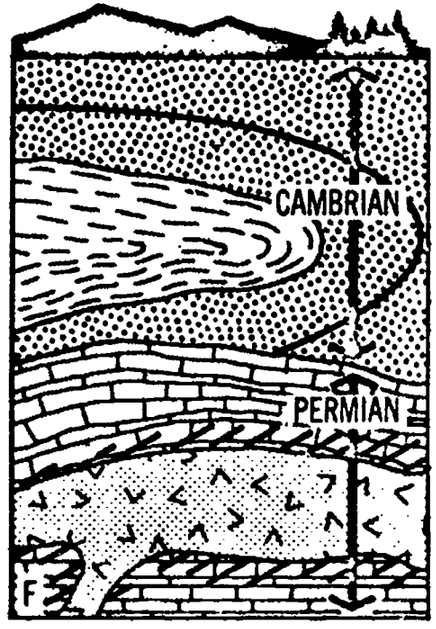

CAMBRIAN
PERMIAN
F

INSTRUCTIONS:

3. Start the audio cassette tape and slides. (For manually operated slide carousels, be sure the slide on the screen is the title slide or the blank colored slide in slot number one. Otherwise, the slides and tape will not be synchronized.) Listen to the tape and view the slides until reference is made to the development of river terraces and you are told to stop the tape. Then STOP THE TAPE AND SLIDES and complete the following exercise.

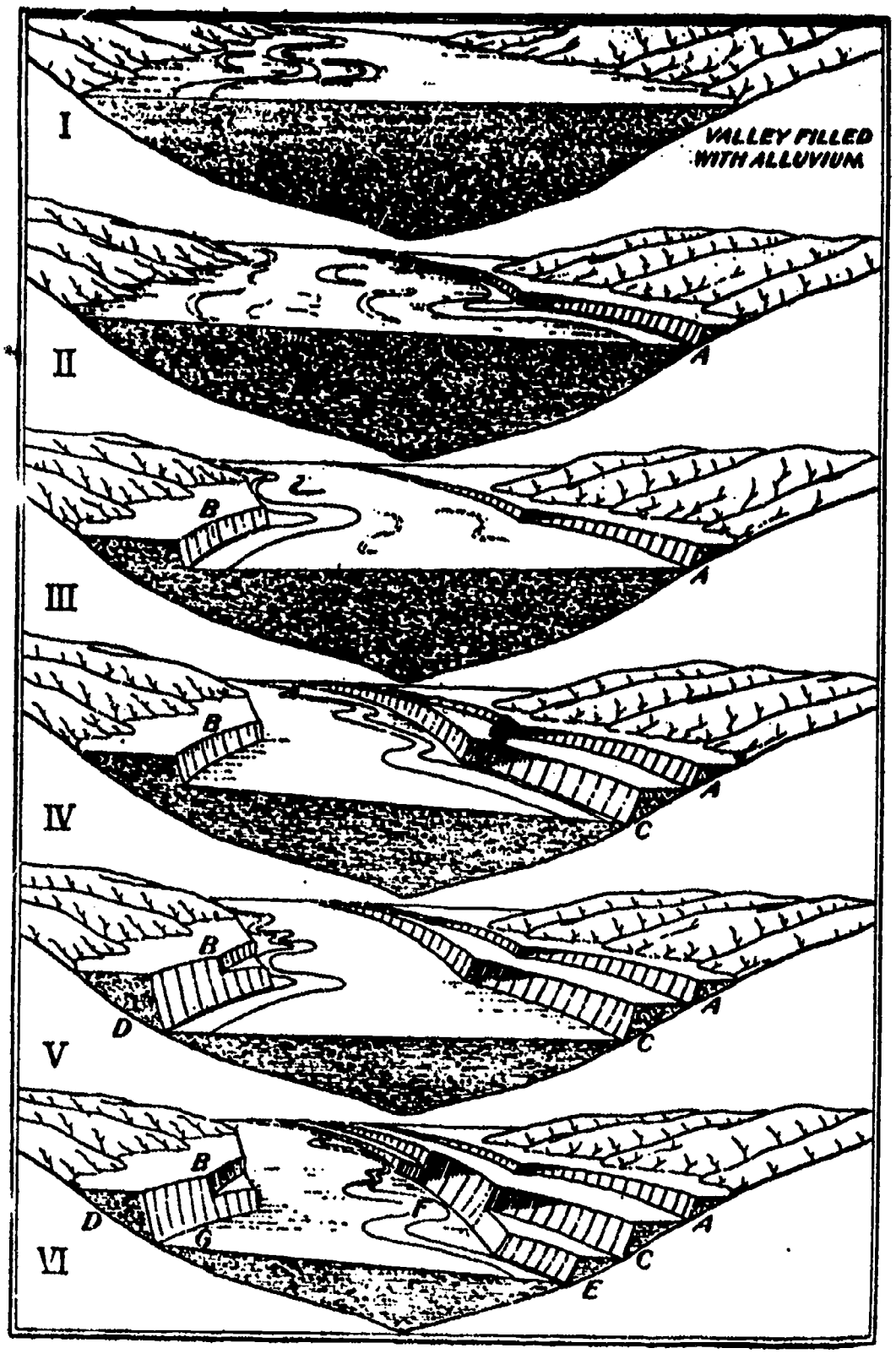
On the following page there are a series of diagrams that illustrate the development of river terraces (these diagrams are duplicated from Lobeck, Geomorphology, McGraw-Hill Book Company, Hightstown, New Jersey, 1939, p. 238). Study these diagrams in sequence beginning with I. Note the changes in each succeeding diagram, II, III, IV, V, and VI. Locate the appearance of terraces at A, B, C, D, and E. As the river meanders and cuts down on the left terrace, A is left on the right. The down-cutting of the river shifts from one side to the other and terraces are left on the opposite side.

When you have studied all the diagrams, carefully complete the following activity on your STUDENT RESPONSE SHEET.

Activity #1

1. Using colored pencils, color each terrace, A, B, C, D, and E, with a different color.

2. What factors would be responsible for determining whether or not the terrace would be on one side or the other?



THE DEVELOPMENT OF RIVER TERRACES

INSTRUCTIONS:

4. Restart the audio cassette tape. Listen to the tape and view the slides to the end of the program. Then STOP THE TAPE AND SLIDES.

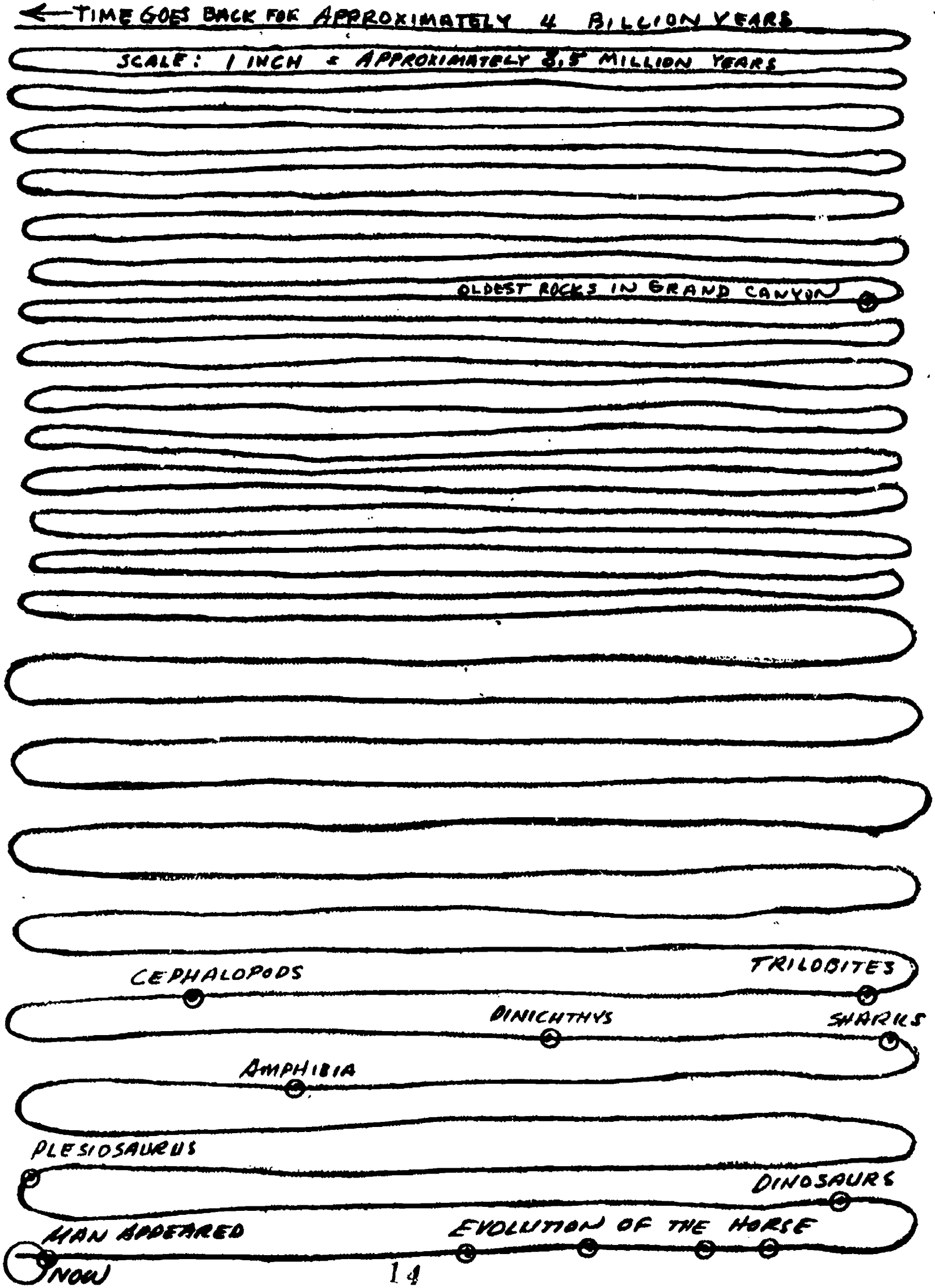
The "Time Machine" will take you through a travelog that illustrates numerous organisms and events on a long term time line. You may stop the tape at any time if you wish to study any examples more extensively than the time allotted between signals to change the slides. However, specific questions or activities have not been designed for this part of the lesson.

On the following page a Geologic Time chart similar to the one you studied in the previous lesson is reproduced. On the page following this chart, a Time Line depicting part of the 4 billion years of the age of the earth has been drawn and many of the events and organisms referred to in the slides have been located. Refer to both of these pages as you listen to the tape and view the slides for the remainder of this lesson.

GEOLOGIC TIME

Relative Duration of Major Geologic Intervals	Era	Period	Epoch	Duration in Millions of Years (Approx)	Millions of Years Ago (Approx)
CENOZOIC			Holocene	Approx. last 5,000 years	
		Quaternary	Pleistocene	2.5	2.5
			Pliocene	4.5	7
MESOZOIC			Miocene	19	26
			Oligocene	12	38
			Eocene	16	54
	Cenozoic	Tertiary	Paleocene	11	65
PALEOZOIC					
		Cretaceous		71	136
		Jurassic		54	190
	Mesozoic	Triassic		35	225
		Permian		55	280
		Pennsylvanian		45	325
		Mississipian		20	345
		Devonian		50	395
		Silurian		35	430
		Ordovician		70	500
	Paleozoic	Cambrian		70	570
PRECAMBRIAN	Precambrian			4,030	

TIME LINE FOR LONG TIME EVENTS



INSTRUCTIONS:

5. Remember to choose one of the program extension activities. Check with your Proctor or Instructor as to when and where this work should be turned in.

ANSWERS TO QUESTIONS IN STUDY GUIDE

ACTIVITY #1 Answers

1. Using colored pencils color each terrace, A, B, C, D, and E, with a different color.

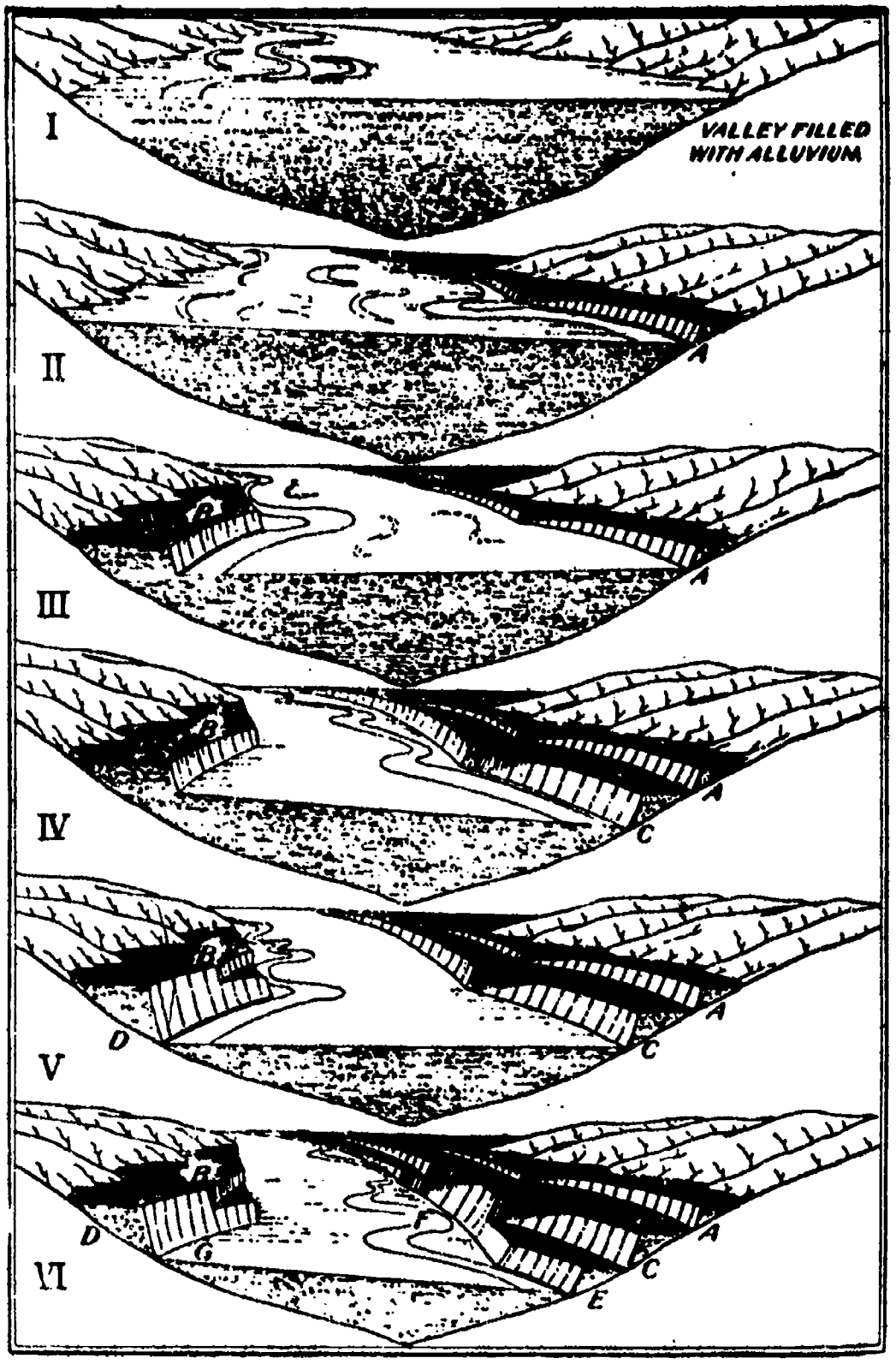
   On the following page the diagram of river terraces has been shaded dark gray or black. Compare your diagrams on which you have used different colors for the terraces indicated.

2. What factors would be responsible for determining whether or not the terrace would be on one side or the other?

   Answer:

   (a) the nature of the soil and rocks on each side

   (b) the down-cutting of the river on one side or the other



THE DEVELOPMENT OF RIVER TERRACES

BIBLIOGRAPHY

Fenton, Carrol Lane and Mildred Adams Fenton. The Fossil Book. Doubleday and Company, Inc., Garden City, New York, 1958, pp. 482. (The Fossil Book is the story of life during the past two billion years. The Fentons tell what fossils are, where they are found, what they mean, and how they are related to plants, animals, and other creatures living on the earth today.)

Matthews, William H. III. Texas Fossils: An Amateur Collector's Handbook, Guidebook #2. Bureau of Economic Geology, The University of Texas at Austin, 1960, p. 123. (Excellent reference for general information about fossil collecting, preservation of fossils, and identification of Texas fossils. This guidebook contains many illustrations of fossils.)

Shelton, John. Geology Illustrated. Freeman and Company, San Francisco, 1969, pp. 480.

SCRIPT FOR LEARNING CARREL LESSON

6.8

LONG TERM EVENTS

ENVIRONMENTAL STUDIES

A Cooperative Project of the Department of Geological Sciences and the Science Education Center.

THE UNIVERSITY OF TEXAS AT AUSTIN

1

Title slide

How about coming with me as we take a journey through time? Not just any kind of time, but a special kind called

2

Geologic time

geologic time. This is the kind of time we use to measure long time intervals, and this program is about events that take a long time to come about. The requirements for the time journey are simple.

3

Relax

First, you must relax but not close your eyes, and second

4

Relax and dream

you must be willing to dream a little, but not too much. We'll start our time journey

5

U.T. campus

with the present. If you were outside today, this is what you would see. Now let's start our time machine

---

6

Time machine

and go back a few years. (honking, then cranking noise giving way to computer sounds)

7

View of old Austin

Your grandfather lived in Austin, and he saw the same view. It looked like this. When grandfather was small

---

8

Another view of old Austin

it looked like this.

9

Indians

Before there was any town, others lived in this spot. To see what they saw, watch carefully.

10

Landscape

Notice the landscape. Geologists tell us that changes in the landscape take place more slowly than changes in vegetation.

11

Landscape

Geologists also tell us that the land looked about as it does today. However, the vegetation was different because of climatic changes.

12

What did this area look like?

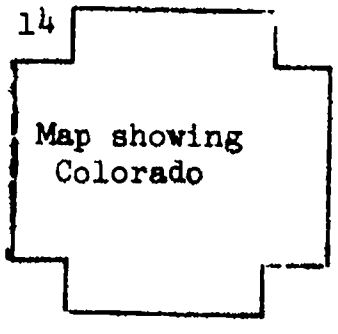
The machine is going again. It's time to take another look. Remember ...

13

Time machine

what you see is what the time machine wants to show. Imagination and reality are many times almost alike.

14



We're here -- three million years ago. The large meanders in the river were developed about this time. Did you see the development of the river terraces? The terraces show changes along the stream margins through time, and developed like you see diagrammed on page 3 of the Study Guide. Stop the tape now and complete the exercise on page 3 in the Study Guide.

15

Welcome back

Welcome back. I hope you enjoyed learning how river terraces develop.

As you could tell, we went a little fast through that three million years to see all that happened. However, our time machine is remarkable because it can take us back in sketches as well as photographs. Pretty clever machine, right? (cranking sound) The machine has started again,

---

16

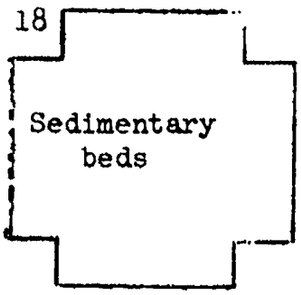
Picture of the Grand Canyon

but our view is that of another location -- the Grand Canyon. Here is the sketch view.

17

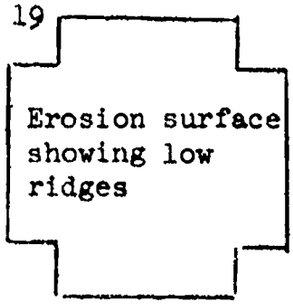
What did the land look like before the Grand Canyon was cut? Geologists tell us it looked like this.

18



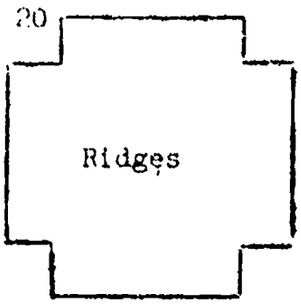
The Colorado River looks like a slow moving stream cutting through sedimentary beds. The horizontal sediments were layed down during Paleozoic time in an enormous sea.

19



Our time machine is running again. Before Paleozoic time, the land was eroded almost flat. Notice the low ridges, formed from down-faulted wedges of resistant rock. Our journey continues.

20



Before the land was smoothed by erosion, it looked like this. The sediments forming these rocks were deposited in a Precambrian sea.

21

Sedimentary rocks

Our time machine shows how they looked at that time. Notice the rocks below? They looked like this.

22

Metamorphic rocks

Where did they come from? The time machine shows they were a major mountain range before the erosion. They were sedimentary rocks earlier,

---

23

Sedimentary rocks

like you see here.

24

?

What was this area like before the sediments were deposited?

25

Blank slide

What's happening to our time machine? (cranking noise, wheezing sounds) It's stopped! Our story's ended.

26

Water scene

No it isn't! It's switched channels. Where will we go? What's this? We're in water and it looks deep. Let's look around while we can. These animals look strange.

27

Paleozoic strata in Grand Canyon

They must be old, about two billion years old, approximately the same age as the oldest rocks in the Grand Canyon. We're off again.

28

Trilobites

What a beautiful view! Those spiny looking creatures are trilobites about 500 million years old. The other animals are sponges and swimming medusas.

29

Cephalopod

Our life forms look different now, 100 million years later in Silurian time. Notice the tabular coral, the red crinoids, the straight-shelled cephalopods, the trilobites, and the small group of brachiopods in the lower right corner.

30

Arthropods

Here's another look at a Silurian Sea. There's two different species of arthropods in view, the larger attaining a length of 6 feet. The smaller ones attacked their prey by jabbing it with the sword-like talon.

31

Large fish
(dinichthys)

This looks like real action is taking place 350 million years ago in the Devonian period, Dinichthys had a head shield more than three feet long, and loved these primitive sharks.

32

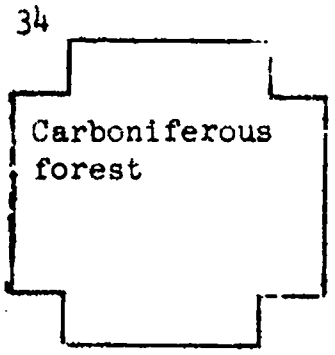
Leafless plants
(psilophytales)

It feels good to get out of the water. This is a Devonian landscape. It looks like plants are growing on the surface. The history of land flora begins with these leafless plants, an extinct group of Psilophytales.

33

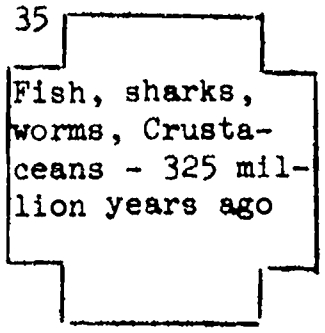
Our time machine continues to work well. This looks like a middle Devonian landscape about 340 million years ago. The land flora is changing in many ways -- greater diversity and larger plant forms.

34



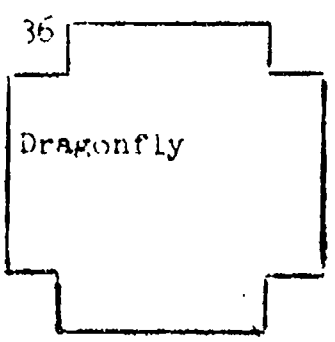
Where are we now? It looks like a Carboniferous forest complete with swamps. The trees with a richly branched crown look like Lepidodendron; the plants with one or more tufts of long narrow leaves are Sigillaria; and the large, articulated trunks with whorls of branches are horse-tails. The trees here were about 70 to 110 feet high; below them moss and ferns are growing.

35



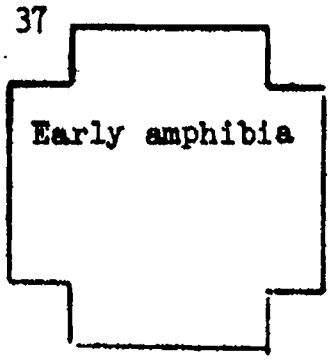
In the waters and mud 325 million years ago, fish, sharks, worms, and Crustaceans were abundant. Here the sharks and fish swim among the fallen debris.

36



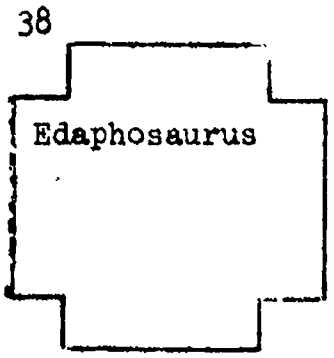
Wow! Look at the dragonfly! It must have a wingspan of nearly 30 inches. Those tree ferns are really something.

37



Two-hundred eighty million years ago we catch a view of early amphibia living in and near the water.

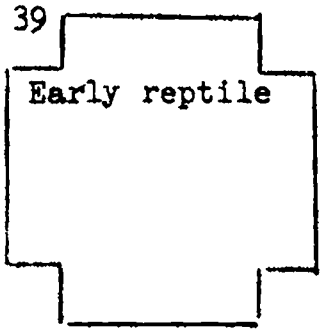
38



Not all the animals lived in the water 290 million years ago. See the Edaphosaurus -- a plant-eating animal, resting between meals.

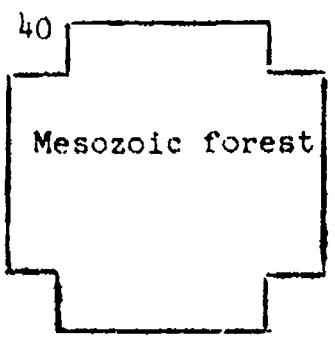
It looks like our time machine is speeding up.

39



Permian time is passing, early Mesozoic time is coming. See the early reptiles. Look at the Mesosaurus.

40

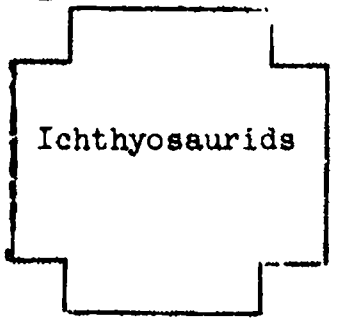


This Mesozoic forest looks like it has real trees.

41

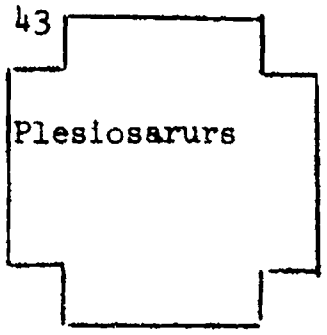
What's happened? What a dry looking place! Where did all the animals and plants go?

42



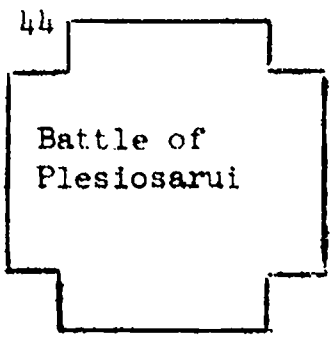
I know these animals. They are Ichthyosaurids or fish lizards. Their average size is 7 feet, but one giant species had an estimated length of 43 feet.

43



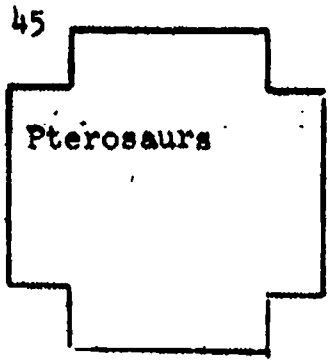
This looks like a Plesiosaurus, a reptile. The machine is slowing down.

44



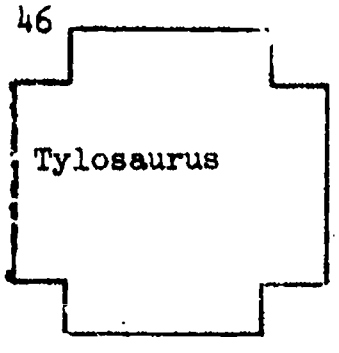
The date is about 130 million years ago, Cretaceous time. What a battle between these large animals! I hope the Pteronodonts don't join in the action.

45



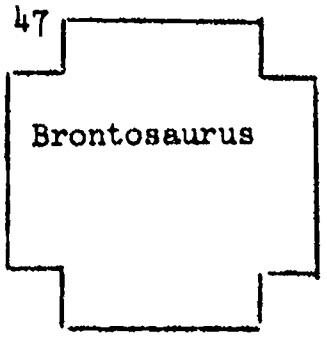
Do you recognize the flying reptiles? They're part of a large group of animals called Pterosaurs. In Cretaceous time there were lots of these. Here are some others with a 26 feet wingspan.

46



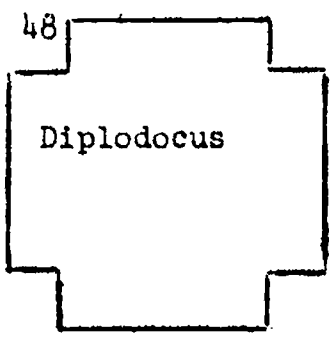
Look at the Tylosaurus. During Mesozoic time the dinosaurs were numerous. I hope the time machine shows us one.

47



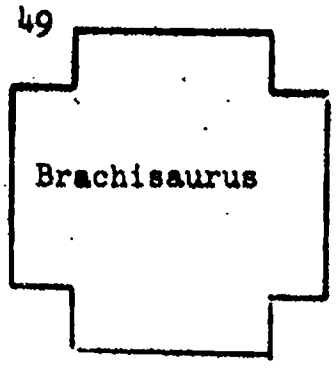
There he is -- a Brontosaurus. It must be about 60 feet long. This is a heavyweight -- 50,000 pounds is my guess.

48



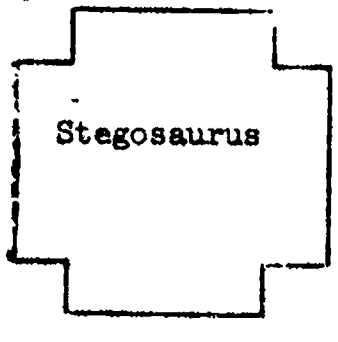
Here's another -- a Diplodocus. From head to tail, I'd guess about 97 feet.

49



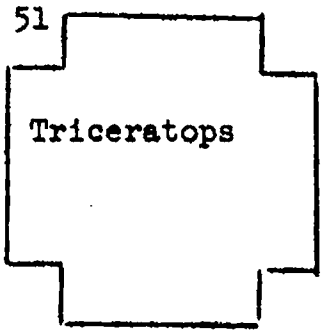
Wow, a Brachisaurus! Its length from mouth to end of tail is 81 feet, 8 inches. The length of the neck is 18 feet, 7 inches. The total height is 43 feet, 4 1/2 inches, and the circumference of the body is about 30 feet.

50



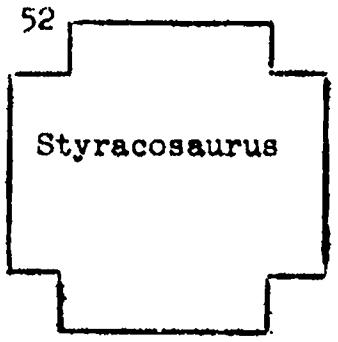
That's a neat one, a Stegosaurus.

51



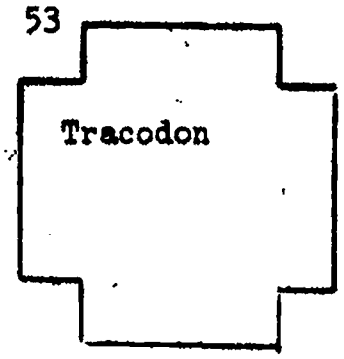
A Triceratops.

52



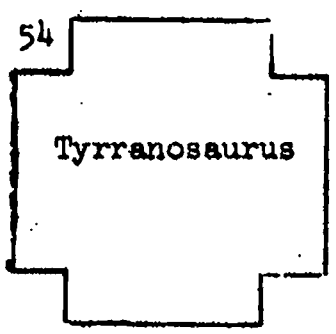
I'd hate to face that one -- it's a Styracosaurus.

53



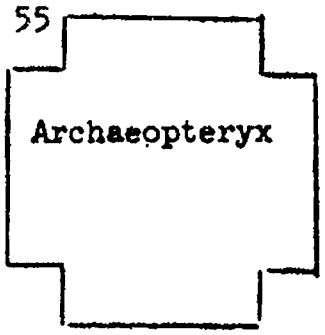
That looks like a duck-billed dinosaur called Tracodon.

54



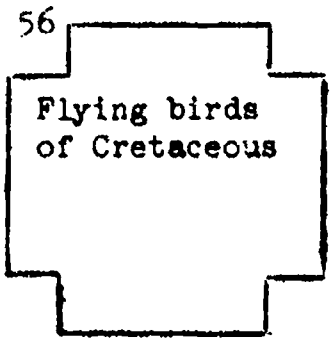
I was hoping we would see one of these. It's a Tyrranosaurus.

55



While we were looking at the dinosaurs we forgot to look around. Here's a Archaeopteryx. These little birds, a little larger than a pigeon, glided from tree to tree, or tree to ground. The clawed digits were used to climb back up for another glide.

56



In the Cretaceous, there were flying birds and aquatic birds. Here we see them clustered together. Flocks of such birds existed.

57

Late Cretaceous

The Cretaceous ends, and with it the dying out of the dinosaurs and many other animals. Our date is now 65 million years ago. There is much to see. Keep going, machine. Here's a big bird. You can see what this bird likes to eat.

58

Forest

That's a beautiful forest. It's about like the ones we see today.

59

Brontotherium

This guy looks larger than a rhinoceros. I believe it's a Brontotherium. The Sioux Indians found its large bones and thought it was the "Beast of Thunder."

60

Mammoth

I don't have to remind you that this is a mammoth, all 12 feet of him. It looks too cold for me.

61

Wooly rhinoceros

The wooly rhinoceros was a companion of the mammoth. That's one.

62

Giant elk (Pleistocene)

Something tells me this is a Pleistocene view, one million years ago. This giant elk had an antler span of 11 feet. As one man said, "A pity, a thousand pities, that this magnificent antler-bearer has become completely extinct." Did I tell you our time machine could back up? Here it goes!

63

Eohippus

What's this? It looks like Eohippus, an ancestral horse, 50 million years ago.

64

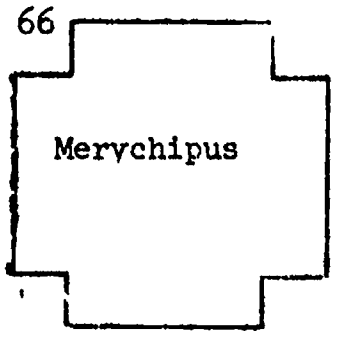
Orohippus

Here's Orohippus, 46 million years ago.

65

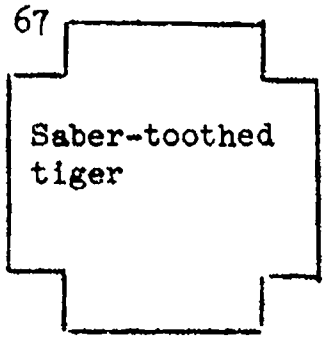
I thought we'd see this next. It's Mesohypus, about 38 million years ago.

66



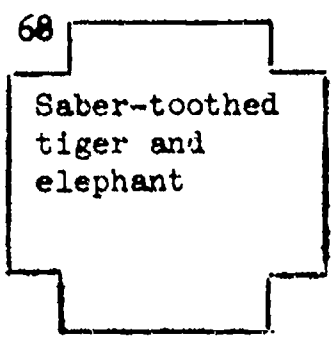
Merychipus looks like a good runner. The date is 26 million years ago.

67



Other animals lived during this time. Here's a mean one -- a saber-toothed tiger.

68



Look, it will even attack an elephant!

69

Bears in Pleistocene

Even the bears were huge in the Pleistocene. Our time machine is tired, and we're almost back. Let's watch carefully and see man appear.

70

Evolution of Man

71

Evolution of Man

72

Evolution of Man

73

Evolution of Man

74

Evolution of Man

75

Evolution of Man

76

U.T. campus scene

We're back. What a trip! Let's review some of the things we experienced.

77

Phylogenetic chart

We noticed that some landscape changes are long term events, that we miss some events if we speed up our time perspective, that the geologic rock record can be deciphered if we make good inferences from our observations, that the evolution of life includes many different life forms and requires vast time intervals, and finally, we noticed that the phyla of living organisms have shown a remarkable persistence through time. The number of organisms in each phylum show variation with time, but most phyla presently living have existed on the earth since late Precambrian time, and let's not forget that the existence of a living organism at a specific time does not guarantee its existence forever. Even man is faced with a survival problem.

78

The End of this Lesson

LESSON 6.8: LONG TERM EVENTS

STUDENT RESPONSE SHEETS

Name _____

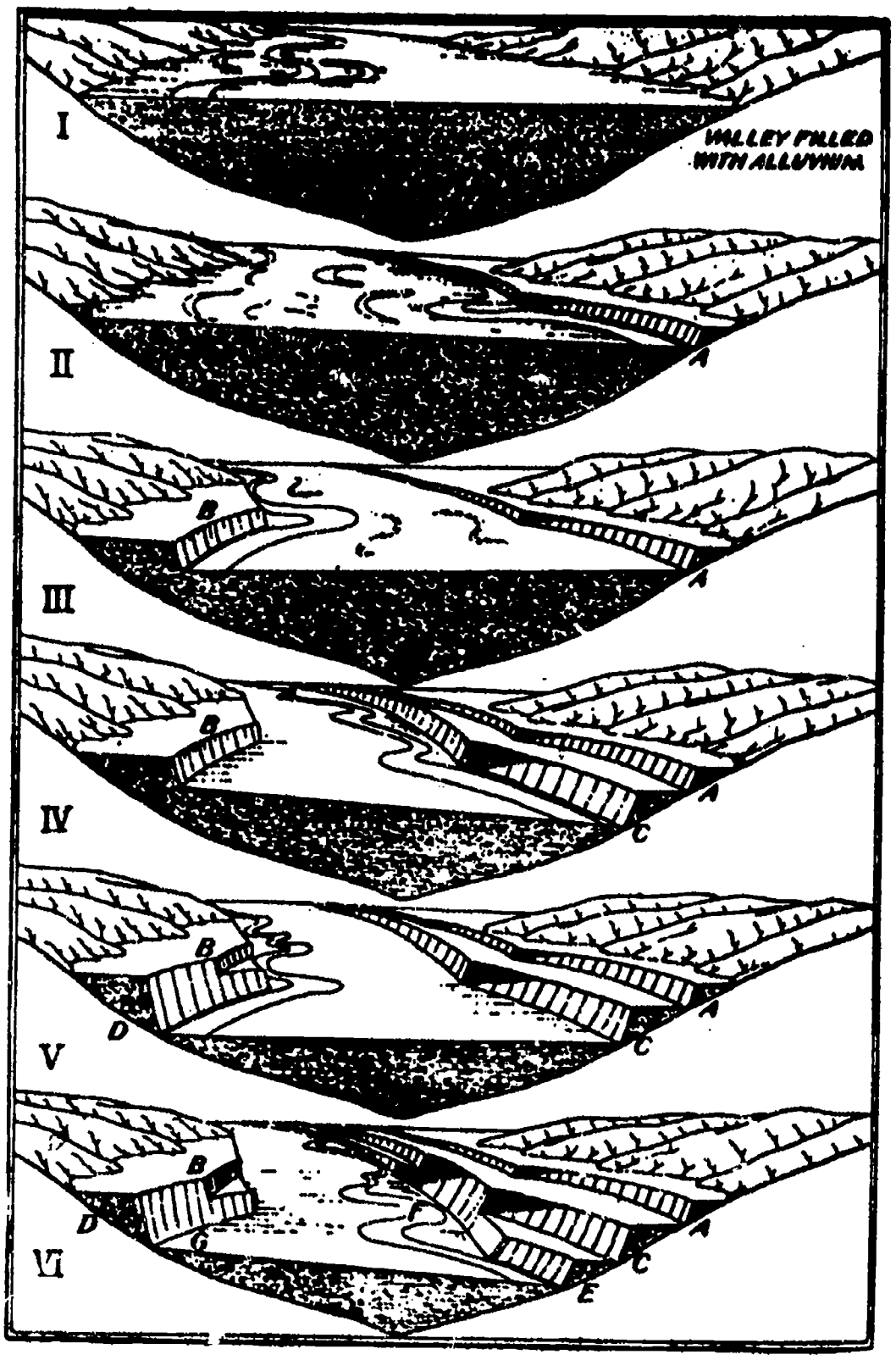
Date _____

LESSON 6.8: LONG TERM EVENTS

STUDENT RESPONSE SHEETS

Activity #1

1. Using colored pencils, color each terrace, A, B, C, D, and E, with a different color in the diagram below.



THE DEVELOPMENT OF RIVER TERRACES.

Name _____

Date _____

LESSON 6.8: LONG TERM EVENTS

STUDENT RESPONSE SHEET

Activity #1 (continued)

2. What factors would be responsible for determining whether or not the terrace would be on one side or the other?